Integrating Variable Energy Resources in New England

Environmental Business Council of New England

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VICE PRESIDENT, SYSTEM PLANNING
Presentation Topics

• The role of ISO New England
• Rapid transformation of the resource mix, and key drivers
• What’s on the horizon for new resources – on the grid, and behind the meter
ISO New England (ISO) Has Two Decades of Experience Overseeing the Region’s Restructured Electric Power System

- **Regulated by** the Federal Energy Regulatory Commission
- **Reliability Coordinator and Planning Coordinator** for New England under the North American Electric Reliability Corporation
- **Independent** of companies in the marketplace and neutral on technology
Reliability Is the Core of ISO New England’s Mission

*Fulfilled by three interconnected and interdependent responsibilities*

- Overseeing the day-to-day operation of New England’s electric power generation and transmission system
- Developing and administering the region’s competitive wholesale electricity markets
- Managing comprehensive regional power system planning
New England Has Seen Dramatic Changes in the Energy Mix: *From Coal and Oil to Natural Gas*

Percent of Total **Electric Energy** Production by Fuel Type
(2000 vs. 2015)

Source: ISO New England [Net Energy and Peak Load by Source](#)

Other renewables include landfill gas, biomass, other biomass gas, wind, solar, municipal solid waste, and miscellaneous fuels
Power Plant Emissions Have Declined with Changes in the Fuel Mix

**Reduction in Aggregate Emissions (ktons/yr)**

<table>
<thead>
<tr>
<th>Year</th>
<th>NO\textsubscript{x}</th>
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<th>CO\textsubscript{2}</th>
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<td>2001</td>
<td>59.73</td>
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<td>2014</td>
<td>20.49</td>
<td>11.68</td>
<td>39,317</td>
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<tr>
<td>% Reduction, 2001–2014</td>
<td>66%</td>
<td>94%</td>
<td>26%</td>
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**Reduction in Average Emission Rates (lb/MWh)**

<table>
<thead>
<tr>
<th>Year</th>
<th>NO\textsubscript{x}</th>
<th>SO\textsubscript{2}</th>
<th>CO\textsubscript{2}</th>
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<td>1999</td>
<td>1.36</td>
<td>4.52</td>
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<tr>
<td>2014</td>
<td>0.38</td>
<td>0.22</td>
<td>726</td>
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<tr>
<td>% Reduction, 1999–2014</td>
<td>72%</td>
<td>95%</td>
<td>28%</td>
</tr>
</tbody>
</table>

Natural Gas Is the Dominant Fuel Source for New Generating Capacity in New England

Cumulative New Generating Capacity in New England (MW)

Note: New generating capacity for years 2016 – 2019 includes resources clearing in recent Forward Capacity Auctions
More Than 4,200 MW of Non-Gas Generation Have Recently Retired or Announced Plans to Retire

More than 25% of the generating fleet is "at risk" for retirement. In December 2012, ISO-NE identified 28 generators "at risk" for retirement (did not include nuclear). Retired 1997 - 2012:

- 3,200 primarily oil, coal and nuclear

In one year (2014), 10% of the fleet announced plans to retire by 2017 (FCA #8 – 3,135 MW).

- 8,300
  - 2,300 Coal
  - 6,000 Oil

Retired 2013 – 2015 or announced retirements through the FCM for 2016 and beyond:

- 4,200 oil, coal and nuclear

Major Retirements:
- Salem Harbor
- Vermont Yankee
- Norwalk Harbor
- Brayton Point
- Mount Tom
- Pilgrim Nuclear
States Have Set Goals to *Increase* Renewable Energy and *Reduce* Greenhouse Gas Emissions

State Renewable Portfolio Standard (RPS) for Class I or New Renewable Energy by 2020

Percent Reduction of Greenhouse Gas (GHG) Emissions Below 1990 Levels* by 2050 (economy wide)

* Vermont’s standard recognizes all forms of renewable energy, and is unique in classifying large-scale hydro as renewable.

* Connecticut’s goal is tied to 2001 levels. Maine’s goal is tied to 2003 levels.
Electric Grid Will Look Very Different in 5 to 10 Years

“Hybrid” grid with grid-connected and distributed resources, and a continued shift toward natural gas and renewable energy
New England Has Significant Wind Potential, But Resources Are Remote from Load Centers

- The ISO identified zones with up to 12,000 MW of onshore and offshore wind potential in a 2009 study for the New England Governors
- More than 4,000 MW are currently proposed, mostly in northern New England
- Transmission would be required to connect potential wind resources to load centers
- New England tariff structure looks to the wholesale power markets to attract new resources; new resources are responsible for funding their interconnection to the transmission network
- Once interconnected, resources have open access to the New England regional network, and compete for use of the network based on their energy offer price

Source: ISO Generator Interconnection Queue (January 2016) FERC Jurisdictional Proposals Only
Transmission Developers Are Proposing to Move Renewable Energy to New England Load Centers

- As of January 1, 2016, eleven elective transmission projects had been proposed in the ISO Interconnection Queue, totaling more than 7,000 MW of potential transfer capability
  - Primarily large-scale hydro resources from eastern Canada and wind resources from northern New England and New York
- Some of these projects are participating in the CT, MA, RI Clean Energy RFP
- These projects seek to address public policy goals, not reliability needs; but could be a factor in planning for public policy under FERC Order 1000

Source: ISO Interconnection Queue (January 2016)
http://www.iso-ne.com/system-planning/transmission-planning/interconnection-request-queue
New Energy Storage Is Emerging in the ISO Generator Interconnection Study Queue

• Over the past year, four battery storage projects totaling almost 150 MW of capacity applied for interconnection to the regional power system

• New England has greatly benefited from energy storage capabilities for more than 40 years
Region Has Successfully Utilized Pumped-Storage Hydro and Flywheel Technologies for Energy Storage

• In New England, the predominant grid-scale energy storage is in the form of pumped-storage hydro
  – Two large facilities built in the 1970s can supply almost 2,000 MW of capacity within 10 minutes
  – Initially developed to provide fast-response capability in the event that a nuclear power plant tripped offline

• From 2008 through 2015, a flywheel system provided regulation service in a pilot program helping balance the instantaneous demand of the regional bulk power system
ISO Paper Explains How Energy Storage Can Participate in the Wholesale Electricity Markets

• Opportunities exist for various types of storage to participate in the energy, capacity, reserve, and regulation markets

• Energy storage is unique because many of these technologies can operate both as a supply resource and a load resource

New England Has Seen Significant Growth in Solar Photovoltaic (PV) Resources

• Solar PV installations across the region are predominantly small (i.e., less than 5 MW) and interconnected to the distribution system through state-jurisdictional interconnection standards

• A majority of solar PV resources do not participate in the region's wholesale power markets

• Because the ISO cannot observe or dispatch most solar PV in the region, these projects act as a modifier of system load

• Solar PV must be accurately forecasted to support the efficient administration of the day-ahead market and the reliable operation of the system in real time

• The growth of solar PV in the region is due in large part to the policies and programs put in place by the New England states
ISO New England Forecasts Growth in Distributed Generation Resources

• Since 2013, the ISO has led a regional Distributed Generation Forecast Working Group (DGFWG) to collect data on distributed generation (DG) policies and implementation, and to forecast long-term incremental DG growth in New England.

• The DGFWG focuses on the following types of DG resources:
  – Under 5 MW
  – Connected to the distribution system
  – Not visible to the ISO directly
  – Specifically solar PV resources, the largest DG component

• The ISO forecasts strong growth in solar PV over the next 10 years.
Draft 2016 Forecast projects more than 3,200 MW installed by 2025
Solar PV Installed Through December 2015

Statewide aggregate solar PV data from regional distribution companies

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<thead>
<tr>
<th>State</th>
<th>Nameplate Capacity (MW_{ac})</th>
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<tbody>
<tr>
<td>Connecticut</td>
<td>188.01</td>
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<td>Maine</td>
<td>15.34</td>
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<td>Massachusetts</td>
<td>947.11*</td>
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<td>New Hampshire</td>
<td>26.36</td>
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<td>Rhode Island</td>
<td>23.59</td>
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<td>Vermont</td>
<td>124.57*</td>
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<td><strong>Total</strong></td>
<td><strong>1,325.00</strong></td>
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* Includes values based on MA SREC data associated with 43 MA municipalities and VT SPEED data for 3 VT municipalities that did not provide individual responses

Solar Power Has a Significant Impact on New England’s Electricity Demand

Solar Power’s Effect on Regional Electricity Demand
May 23, 2015

Estimated Electricity Needs Served by Solar Power | Demand Without Solar Power | Electricity Demand Seen in Real Time

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Megawatts (MW)
State Installed Solar PV “Heat Maps”

- Understanding the spatial distribution of existing solar PV resources will be critical to the ISO’s ongoing integration activities within both System Planning and System Operations.

- Based on the data provided by distribution owners, the ISO has aggregated the installed nameplate capacity by town within each state, and generated heat maps showing the results.

*Note:* Heat map reflects solar PV installed through August 31, 2015.
Massachusetts Installed Solar PV “Heat Map”

Note: Heat map reflects solar PV installed through August 31, 2015.
The ISO Is Leading Efforts to Account for Solar Resources Connected to the Distribution System

• **Forecasting Long-Term Solar Growth**
  – The ISO tracks historical growth and predicts levels of solar development 10 years into the future
  – The solar forecast is used in transmission planning and market needs assessments; solar PV impacts are already accounted for in wholesale power market requirements

• **Forecasting Short-Term Solar Performance**
  – The ISO creates daily forecasts of solar generation production to improve daily load forecasts and situational awareness for grid operators

• **Improving Interconnection Rules**
  – The ISO is engaged with industry stakeholders to strengthen interconnection standards and reduce reliability concerns
The ISO Is Improving the Ability of Intermittent Resources to Participate in the Wholesale Markets

✓ **Flexibility to Offer Negative Prices**
  – Allows generators, like wind, the opportunity to operate during low-load conditions when they otherwise might be curtailed

✓ **Updated Elective Transmission Upgrade (ETU) Rules**
  – Improve the interconnection study process for ETUs and ensure these resources are able to deliver capacity and energy into the wholesale electricity markets

○ **Flexibility to Operate Up to a Certain Level**
  – Allows the ISO to better manage transmission congestion in a way that will maximize the use of low-cost renewable resources and alleviate the need for curtailments (effective May 2016)
  – Known as “Do-not-Exceed Dispatch Order”
ISO Analysis on Integration of Renewable Resources

• New England Wind Integration Study

• Economic Study in support of New England Governors’ Renewable Energy Blueprint

• ISO New England Energy-Efficiency Forecast Report for 2019 to 2024

• Solar PV 2016 Forecast (draft)

• 2015 Economic Studies for On-shore and Off-shore wind
Conclusions

• New England is transitioning to a system with *decreasing* amounts of traditional resources (coal, oil, nuclear) and *increasing* amounts of renewable energy.

• Transmission investment will be required to incorporate large amounts of wind.

• Improved access to solar PV data is needed for operations and operations forecasting.

• Enhanced solar PV interconnection standards are required to support reliability and get maximum benefit from solar PV installations.

• The ISO is working with stakeholders to enable the successful integration of these variable energy resources.
For More Information...

• Subscribe to the ISO Newswire
  – ISO Newswire is your source for regular news about ISO New England and the wholesale electricity industry within the six-state region

• Log on to ISO Express
  – ISO Express provides real-time data on New England’s wholesale electricity markets and power system operations

• Follow the ISO on Twitter
  – @isonewengland

• Download the ISO to Go App
  – ISO to Go is a free mobile application that puts real-time wholesale electricity pricing and power grid information in the palm of your hand
Questions
The ISO Accounted for Solar PV Resources in the Most Recent Forward Capacity Auction

• The Installed Capacity Requirement (ICR) for a Forward Capacity Auction (FCA) is the **minimum level of capacity** required to meet reliability requirements for the New England Control Area for the relevant Capacity Commitment Period (three years in the future)

• The ICR is based on **three essential components**: the load forecast, resource availability, and tie benefits

• In its order accepting the ICR for FCA #9, the Federal Energy Regulatory Commission (FERC) directed the ISO to fully explore the incorporation of distributed generation resources into the ICR calculation for **FCA #10**
The ISO worked with stakeholders through the DGFWG to develop the 2015 solar PV forecast.

Through that forecast, the ISO identified behind-the-meter solar PV resources that are forecasted to be installed, or that have already been installed, but are not yet reflected in historical loads.

- Referred to as “behind-the-meter not-embedded-in-load” (BTMNEL) solar PV resources.

The ISO adjusted the load forecast by the forecasted BTMNEL solar PV resources, resulting in a **390 MW reduction** in the ICR for FCA #10.
The ISO Accounted for Solar PV Resources in the Most Recent Forward Capacity Auction, continued

• On January 8, 2016, FERC accepted the ICR for FCA #10 and found that the ISO properly incorporated BTMNEEL solar PV resources into the ICR calculation.

• On February 8, 2016, the ISO conducted FCA #10, procuring the capacity resources needed to meet the ICR for the 2019-2020 Capacity Commitment Period.
  – About 35,567 MW of capacity cleared the auction to meet the 34,151 MW ICR for 2019-2020.